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European Research Council

BriX

First results on visualization of the acetone supersonic gas jet by means of the PLIF-technique.

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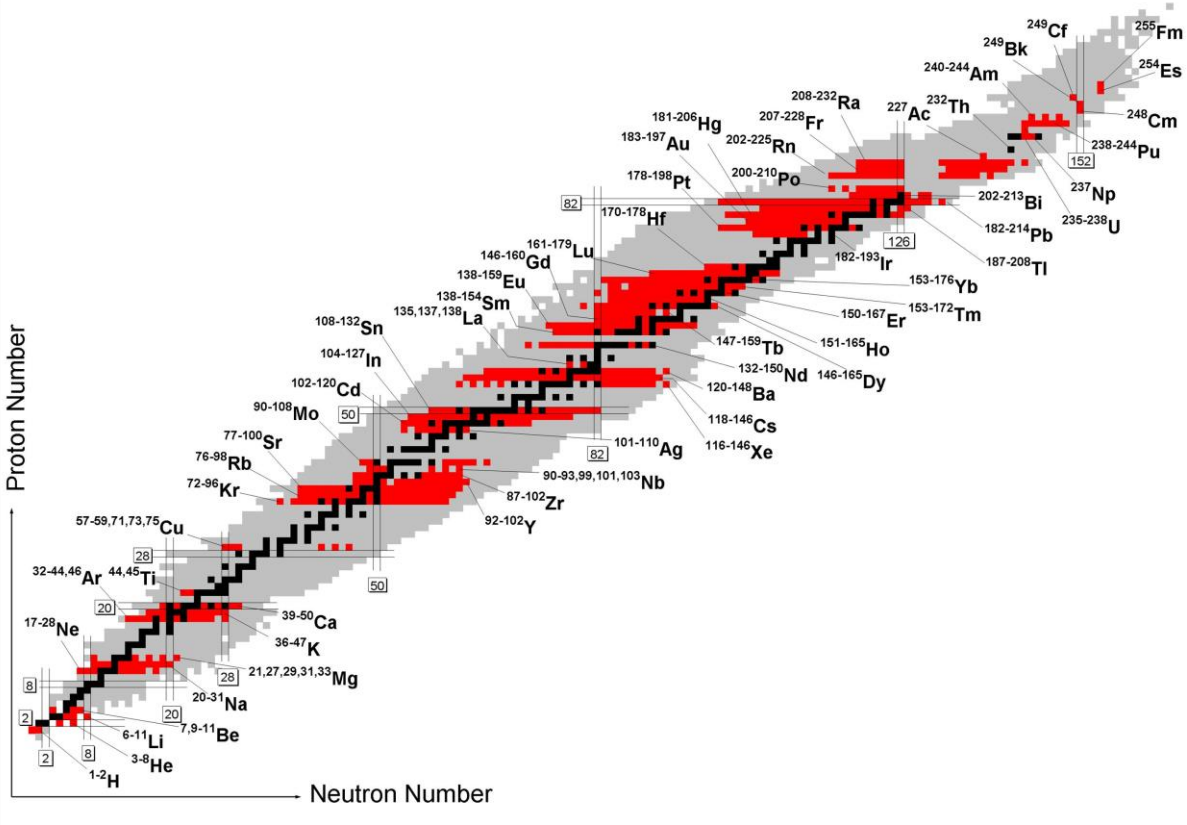
Plan:

1. Goal of the research;
2. Experimental technique;
3. The first results on the PLIF-tests from the IGLIS-laboratory;
4. Conclusions.

Heavy Elements Laser IOnization and Spectroscopy → HELIOS project (KU Leuven)

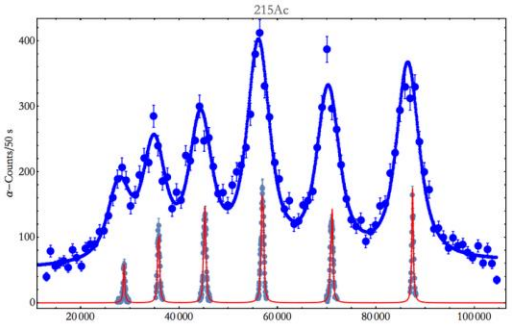
The goal of the project: to study nuclear and atomic properties of isotopes of the heavy elements.



Ways to enhance the spectral resolution and efficiency:

1. Low temperature ($\Delta\vartheta_{Doppler\_T} \sim \vartheta * \sqrt{T/A}$);
2. Low density ($\Delta\vartheta_{Collision} = \gamma^{293K} * (T/T_{293K})\text{^}0.3 * \rho$);
3. Uniform jet.

→ μeV (hyperfine structure)!



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In-gas-jet laser spectroscopy (experimental layout)

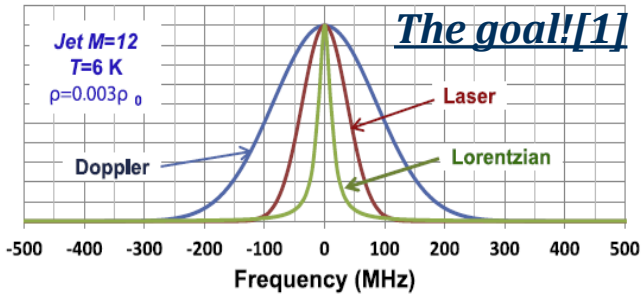

Fig. 9. Gaussian, Lorentzian, and laser contributions to the shape of a spectral line in a supersonic gas jet of Mach number $M = 12$

[1] Yu. Kudryavtsev et al, NIM B 297 (2013) 7 - 22

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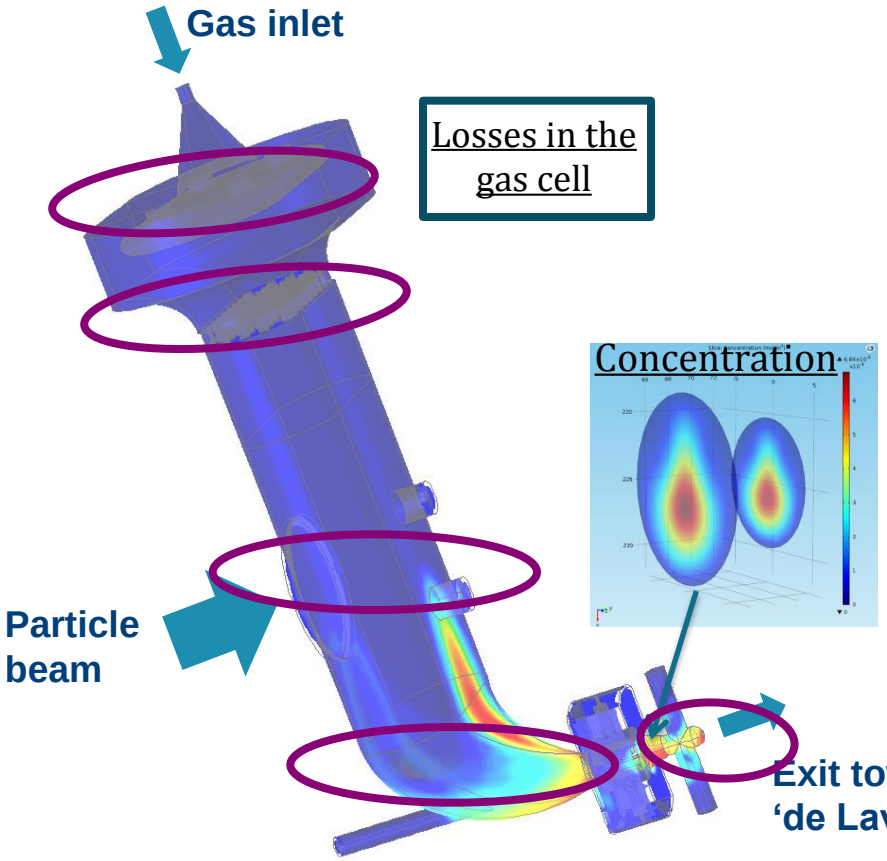
Optimization of the gas cell and of the de Laval nozzle

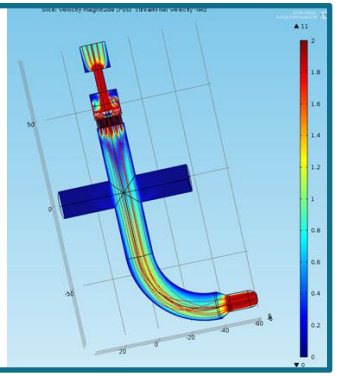
1. Gas cell



Important features in the optimization:

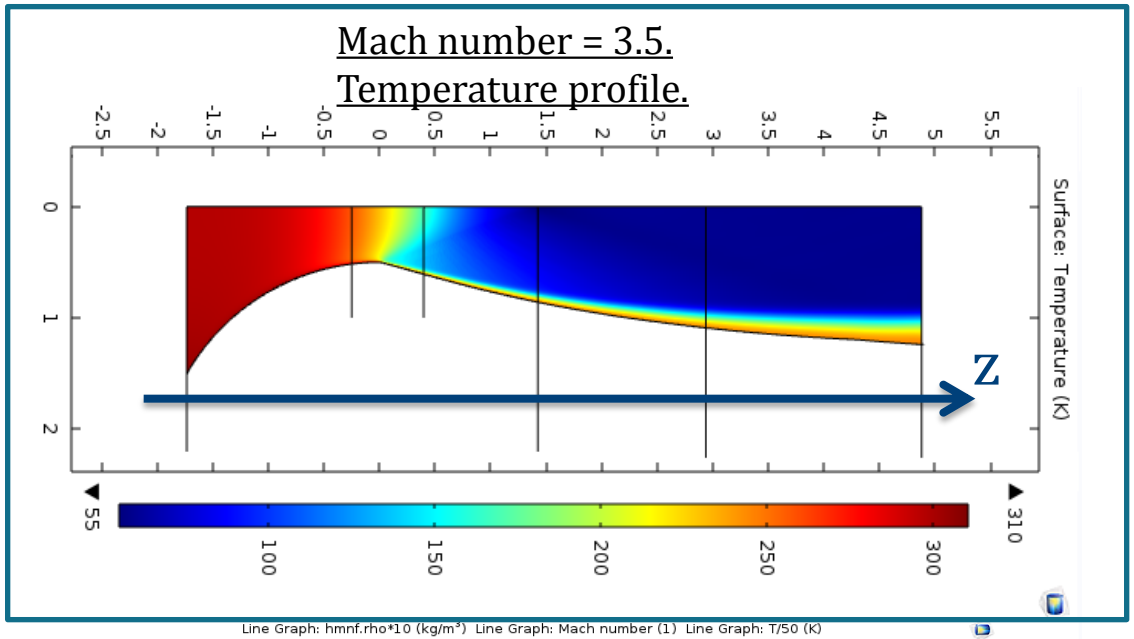
1) Decrease the velocity of the flow after the inlet;
2) Form the non-turbulent flow;
3) Avoid the losses of the nuclear reaction products on the walls of the cell;
4) Decrease the losses on the turning path;
5) Optimization of the diameter of the exit.

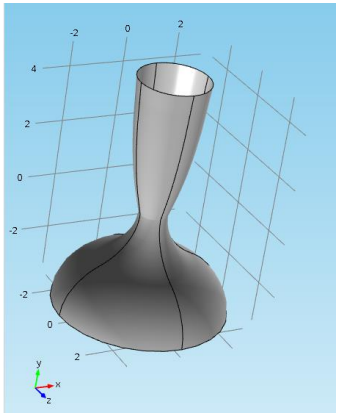
Gas cell for the first tests:

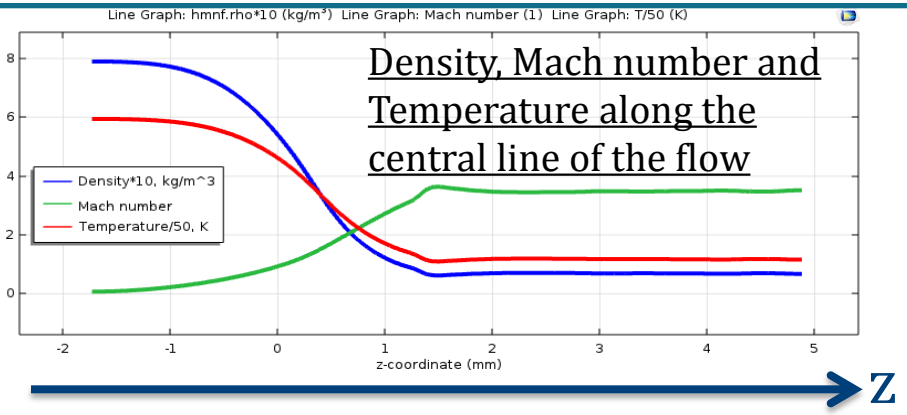


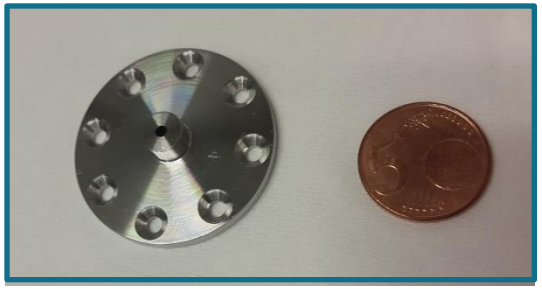
Optimization of the gas cell and of the de Laval nozzle

2. De Laval nozzle









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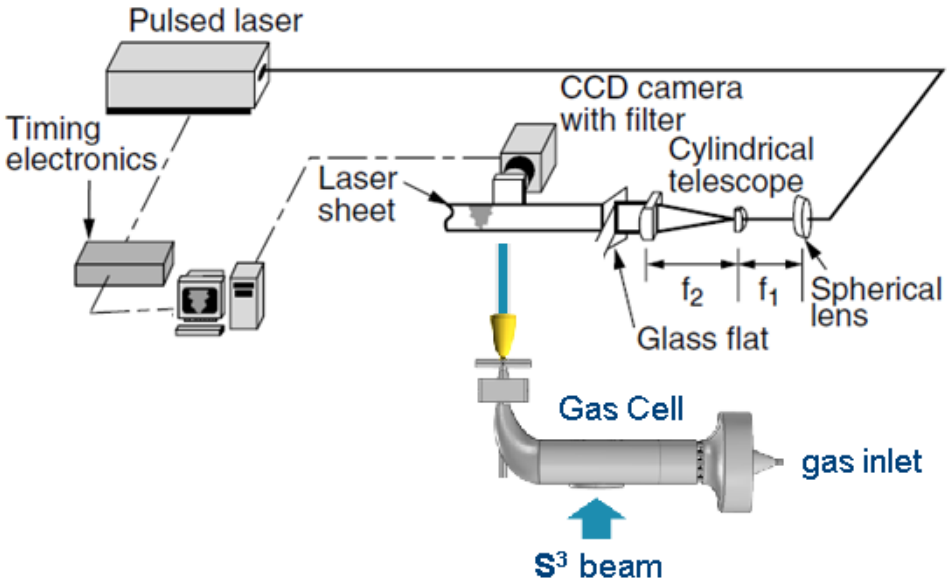
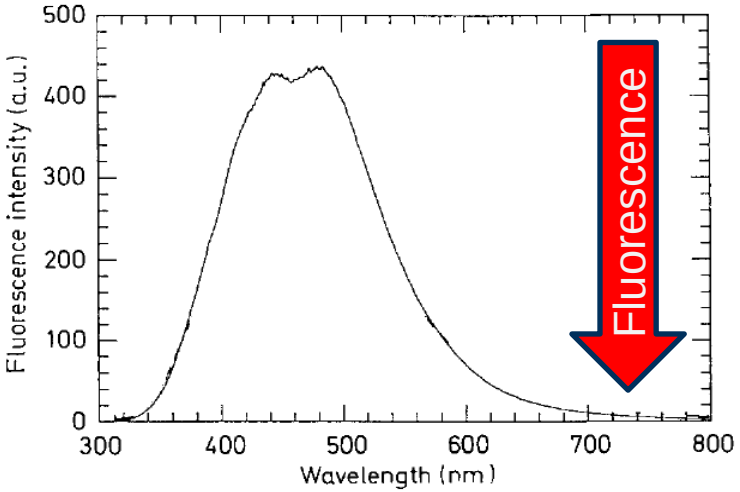
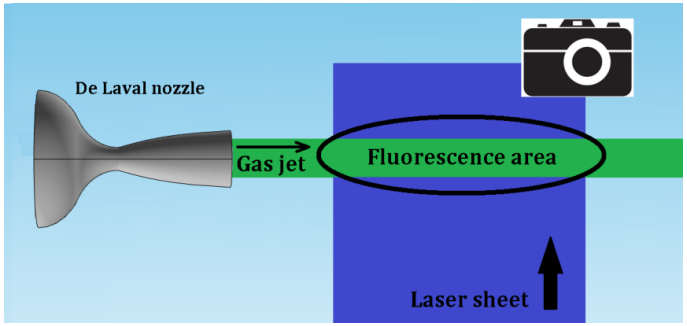
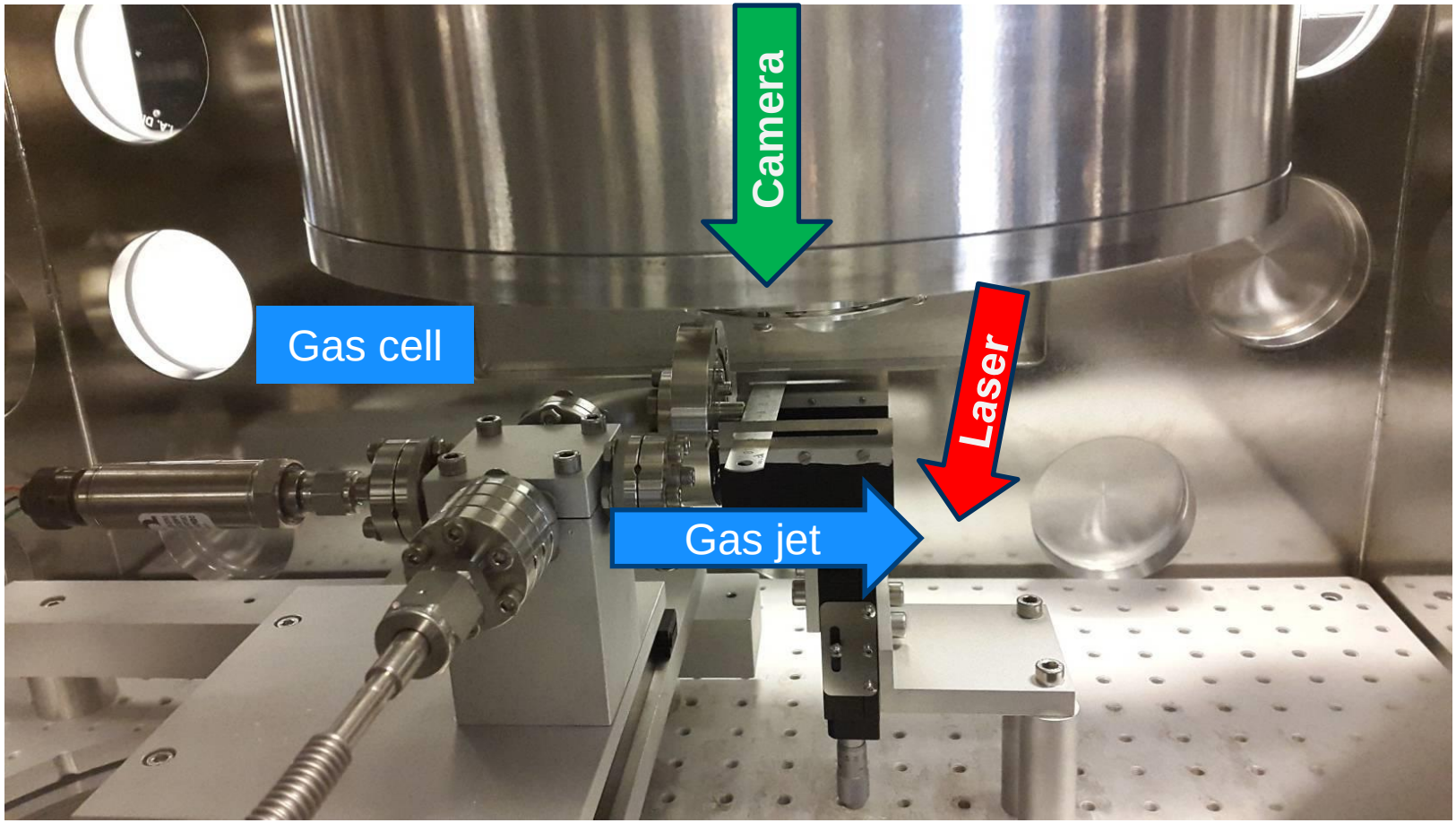
Planar Laser Induced Fluorescence - technique (PLIF)

In order to obtain information about *density, temperature and velocity distributions* for the gas jet and for the isotopes in the gas jet we can use PLIF-technique.





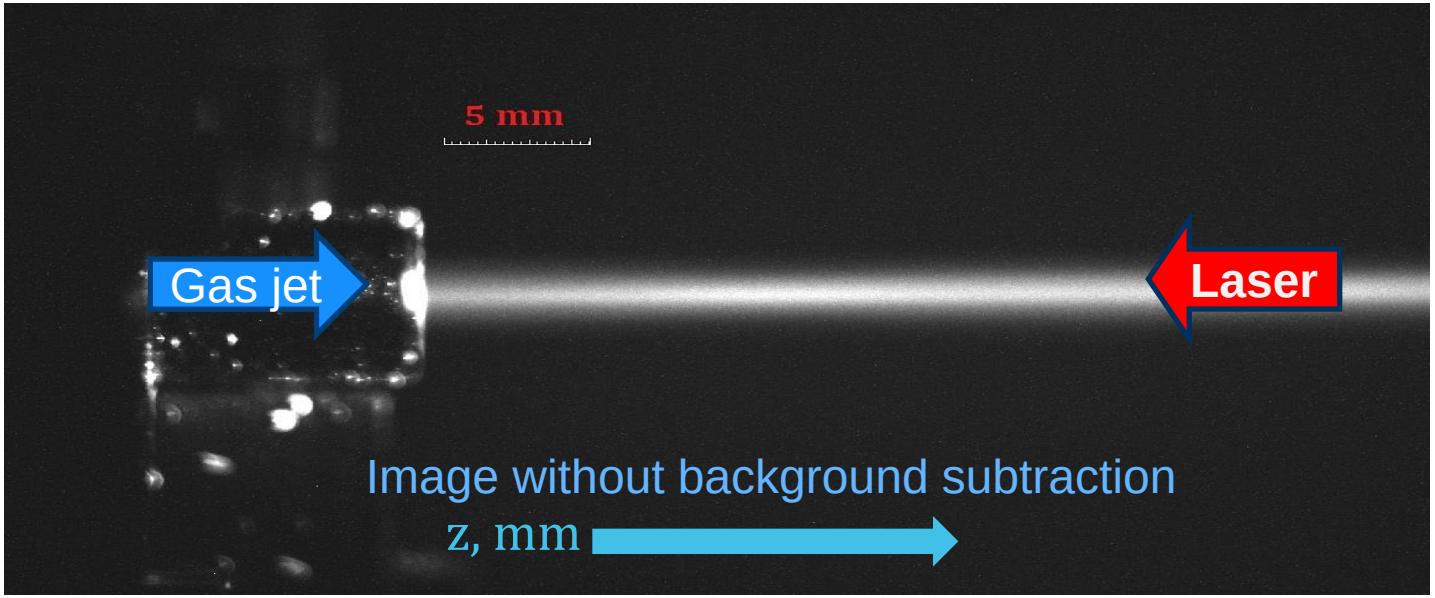


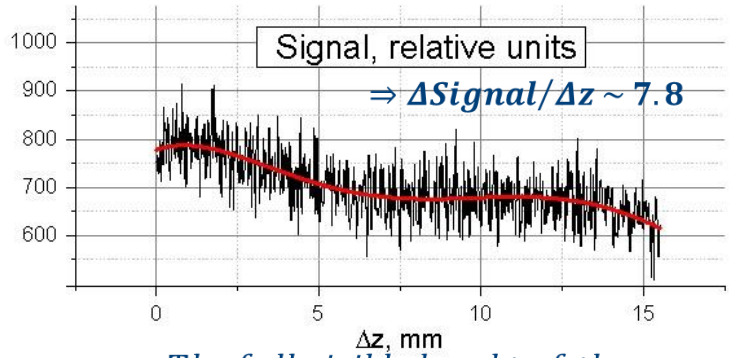

Camera
Laser
Gas cell
Gas jet

Acetone PLIF (longitudinal direction)

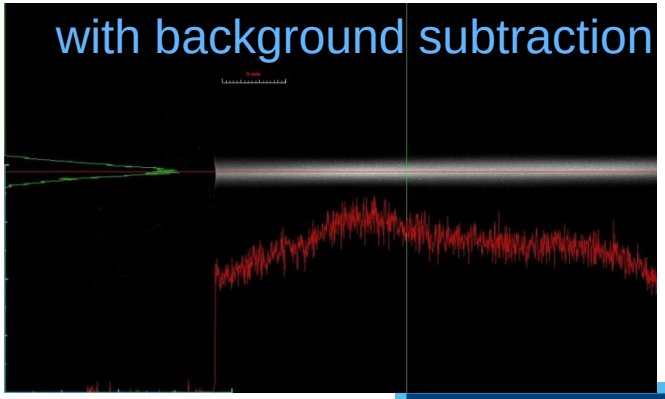
*images were taken with the CMOS camera Hamamatsu Photonics, C11440-42U.

P0 = 1350mbar; P_jet_5.5 = 3.3mbar. P1 = 4mbar. **P1>P_jet!**





The full visible lenght of the gas jet during the test ~ 15 cm



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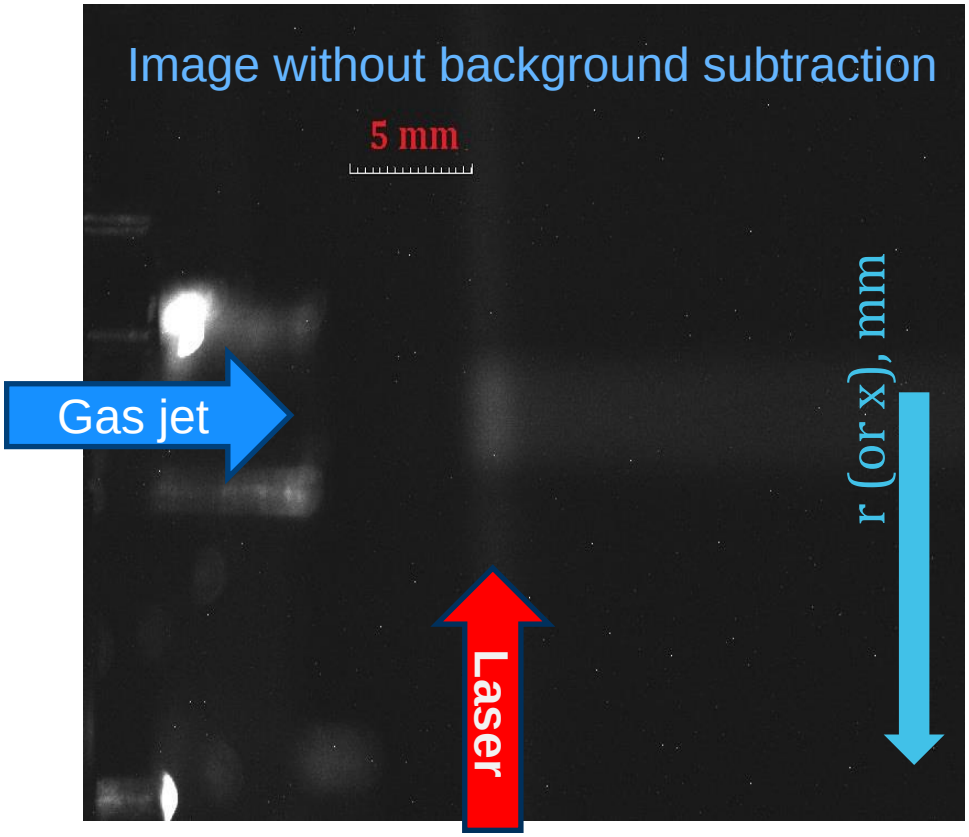
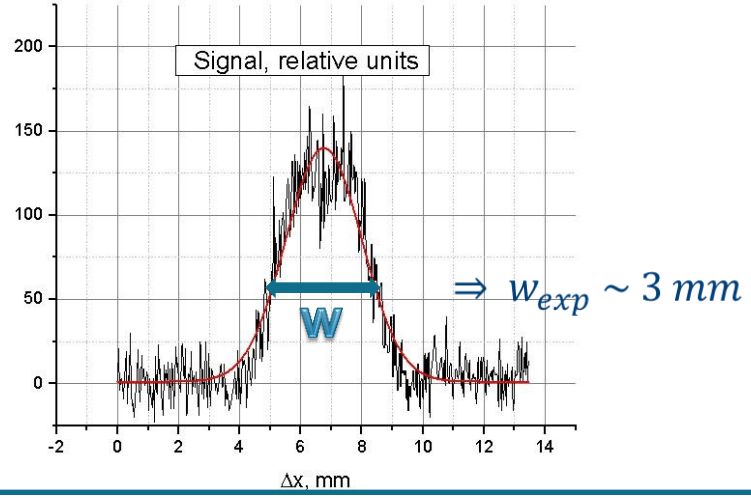
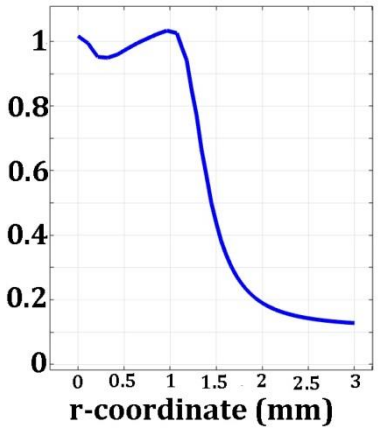
Acetone PLIF (transversal direction)

*images were taken with the CMOS camera Hamamatsu Photonics, C11440-42U.
P0 = 1350mbar; P_jet_5.5 = 3.3mbar. P1 = 4mbar. **P1>P_jet!**







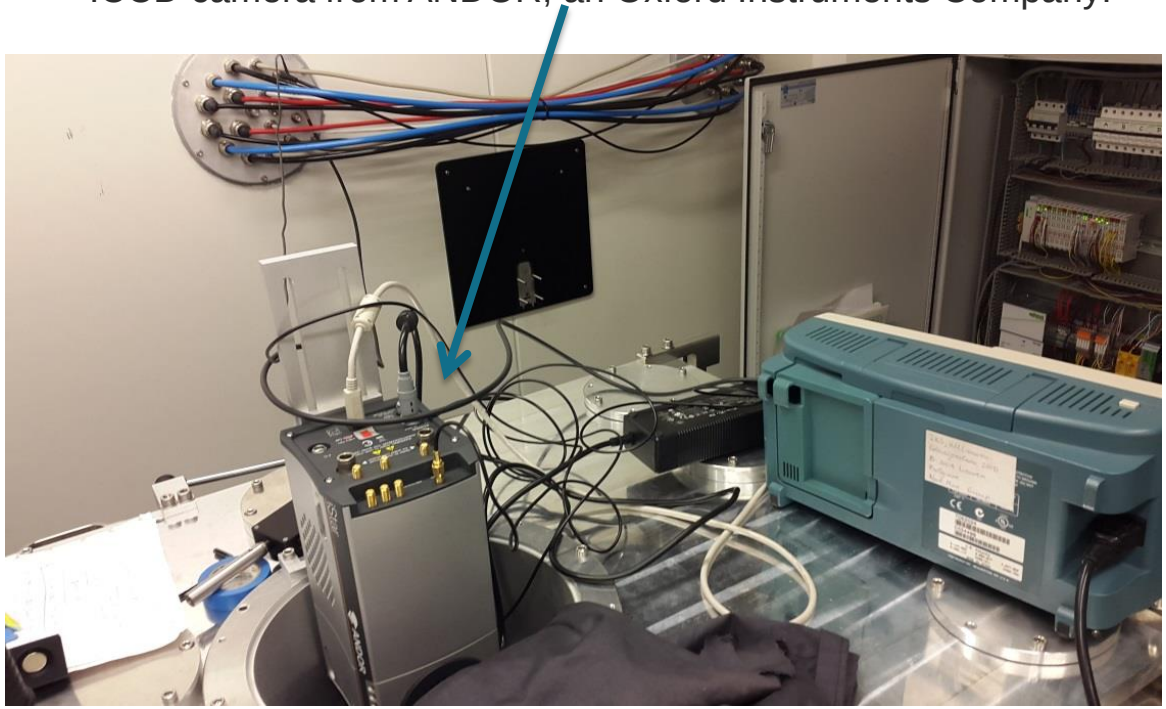
Normalized density at 5mm distance from the exit of the de Laval nozzle*

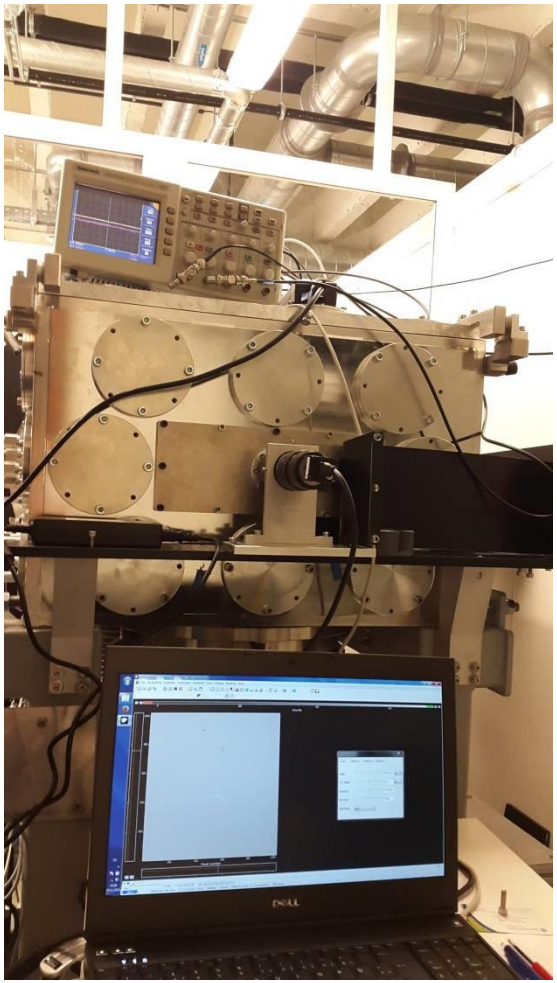
$\Rightarrow w_{comp.simulations} \sim 2.9\ mm$

*Simulations in COMSOL Multiphysics

Tests with ANDOR camera and acetone gas jet :

ICCD camera from ANDOR, an Oxford Instruments Company:

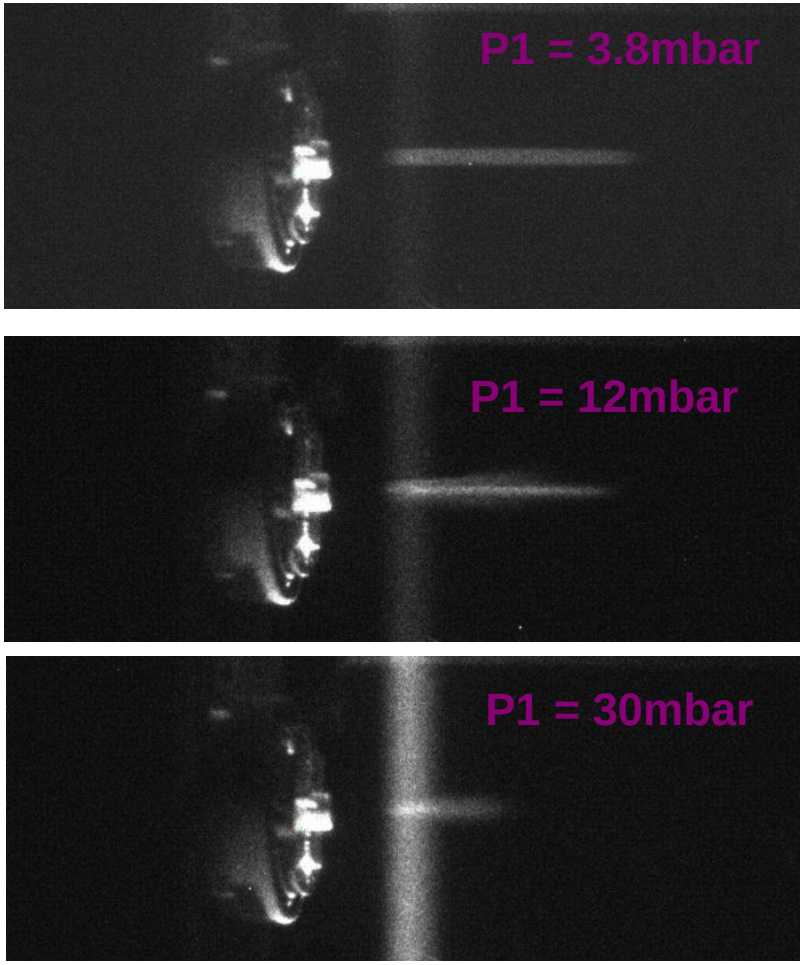




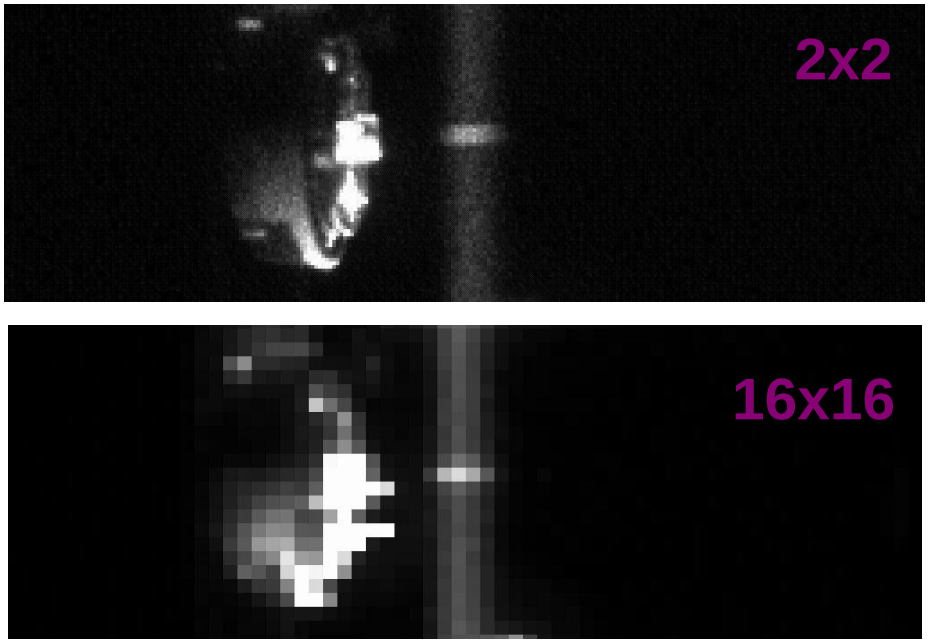
Acetone PLIF (transversal direction)

P0 = 1230mbar; P_jet_5.5 = 3mbar

Background pressure P1 was varied during the test.

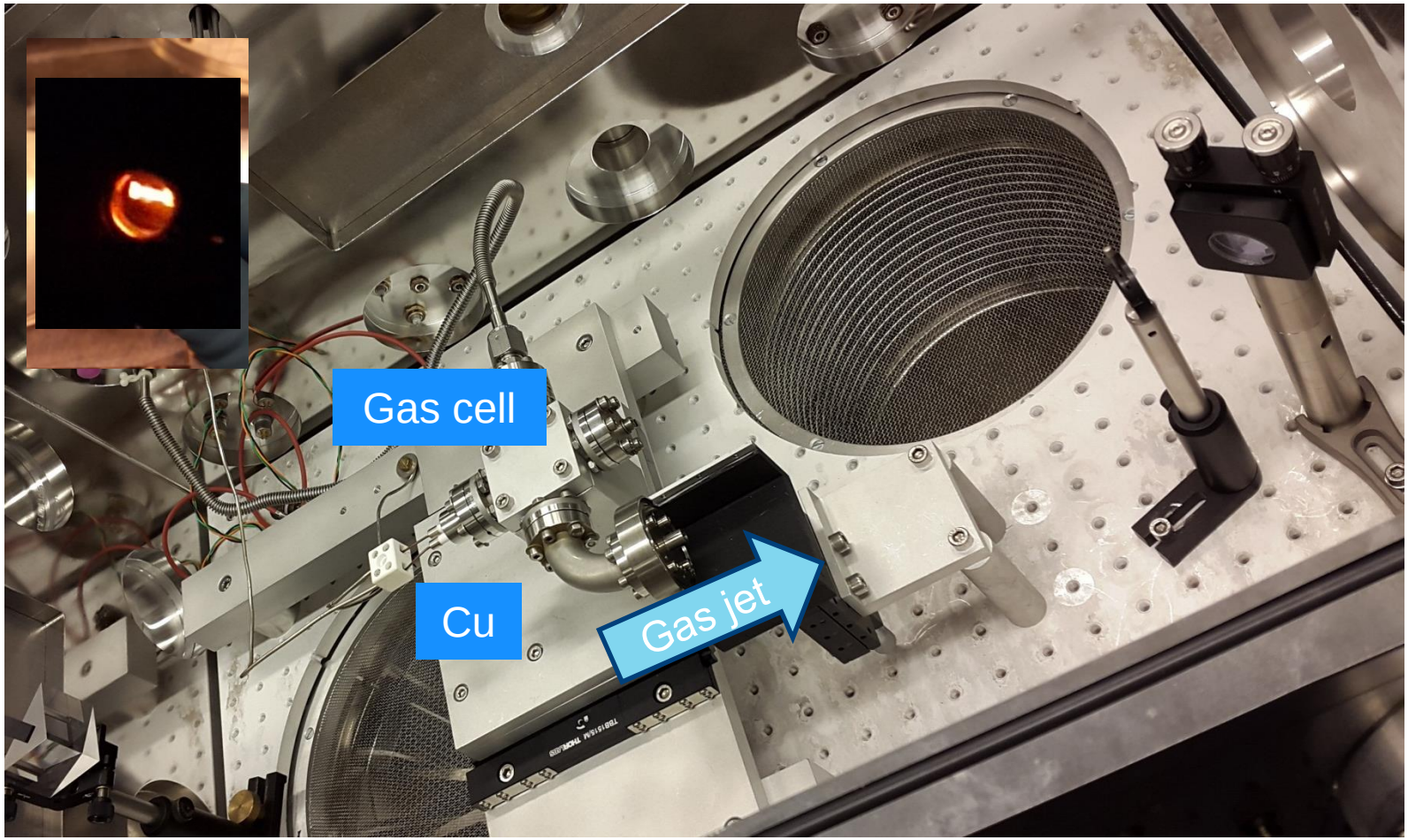


Binning.



Copper PLIF (the ongoing test)

ICCD camera from ANDOR, an Oxford Instruments Company:



Conclusions

- The first experimental tests on the visualization of the acetone supersonic gas jet were performed and the preliminary analysis shows a good agreement between the experimental data and the output from the computer simulations;
- More tests on searching for the copper fluorescence signal still need to be performed..

Thanks to the Nuclear Spectroscopy Group!

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A. Zadvornaya

Thanks for your attention!

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